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Feedback-signaling for multicast data transmission

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DESCRIPTION

Feedback signaling for multicast data transmission

The present invention relates to data transmission in a multicast fashion. In particular, the present invention relates to a method of performing a point-to-multipoint data transmission from a transmitting station to a plurality of receiving stations, a data transmission system for performing a point-to-multipoint data transmission from a transmission station to a plurality of receiving stations, to a transmitting station for a data transmission system for a point-to-multipoint data transmission from the transmission station to a plurality of receiving stations and to a receiving station for a data transmission system for a point-to-multipoint data transmission from a transmitting station to a plurality of receiving stations.

Data transmission in a multicast fashion usually causes difficulties when retransmissions of the data are applied in order to increase the chance of correct decoding for a maximum of the recipients, since each recipient has to send its feedback separately to one sender, which causes a huge amount of feedback signaling in case the multicast reception group is large. Multicast data transmission or point-to-multipoint data transmission relates to a data transmission where one sender once sends data, such as a data packet, to a number of recipients and each recipient decodes this (single physical representation of the) data.

If the same data is to be conveyed to a number of recipients, such as, for example, in the case of a base station of a mobile communication system via a wireless transmission channel to a number of recipients in a radio cell, it may be advantageous to send each packet only once to all recipients in a broadcast manner and let all recipients decode this one packet. In other words, on a physical level, only one point-to-multipoint channel (p2m) is used, as opposed to a plurality of point-to-point channels (p2p-channel) for each recipient individually. Usually, the data is transmitted in the form of data packets.

Possible approaches to improve the reliability of such data transmission are:

- forward error correction (FEC), which adds redundancy to the data bits of a data packet, so that the receiving side may detect and correct errors in a data packet
- retransmitting data packets on request of the receiving side, if the receiving side is not able to correct all errors contained in the received data packets. Such retransmissions can be either full copies of the initially transmitted packet, or a retransmission can contain different data, e.g. only additional parity bits, which together with the received bits of the initially transmitted packet are considered in the decoding process. To cover both cases, here the term "retransmission *for* a packet" instead of "retransmission *of* a packet" is used.

Both of the above approaches are usually applied when data packets are transmitted via a p2p channel.

For transmission via a p2m channel, the retransmission of data packets may be problematic, since each recipient has to send its feedback to the sender. Thus, the sender has to cope with as many feedback messages as there are recipients for each data packet transmitted. This may cause a huge amount of signaling in the direction from the recipient to the sender, if the number of recipients in the multicast group is large. Also, if at least one of the recipients asks for a retransmission, it is necessary to perform another point-to-multipoint transmission of the data, i.e. another transmission of the data to all of the recipients.

In other words, due to the large amount of signaling in the direction from the recipient to the sender, such known point-to-multipoint transmission occupies a lot of channel capacity in the direction from the recipient to the sender, and generates significant interference, and thus may be inefficient in case the number of recipients in the multicast group is large.

It is an object of the present invention to provide an efficient feedback signaling mechanism for point-to-multipoint data transmission.

According to an exemplary embodiment of the present invention as set forth in claim 1, the above object may be solved by a method of performing a point-to-multipoint data transmission from a transmission station to a plurality of first receiving stations, wherein the data is transmitted from the transmitting station to the plurality of first receiving stations. Then, at the transmitting station, a confirmation message with respect to the data is received from at least one second receiving station of the plurality of first receiving stations. The transmitting station transmits (possibly together with a further data packet) the confirmation message, which it received from the at least one second receiving station, to at least one third receiving station of the plurality of first receiving stations.

In other words, according to an aspect of this exemplary embodiment of the present invention, the confirmation message relating to the decoding of the data at the at least one second receiving station is mirrored by the transmitting station to at least one third station of the plurality of first receiving stations. Due to this, the at least one third receiving station is informed about the decoding result of the data at the at least one second receiving station. Due to this knowledge, advantageously, the at least one third receiving station may decide what to do next. According to an aspect of this exemplary embodiment of the present invention, the data may relate to user data transmitted via a data channel or to control data transmitted via a control channel.

In case the confirmation is a negative acknowledgement message indicating that the at least one second receiving station unsuccessfully decoded the data as set forth in another exemplary embodiment of the present invention (according to claim 2), the at least one third receiving station knows that a retransmission for the data packet may happen anyway, due to the fact that the at least one second receiving station was not able to decode the data packet error-free. In such a case, according to an aspect of this exemplary embodiment of the present invention, the at least one third receiving station

may decide not to perform a transmission of its own confirmation message relating to the own decoding of the data packet to the transmission station. Advantageously, this may allow for a reduction of feedback signaling.

On the other hand, in case, as set forth in the exemplary embodiment of the present invention according to claim 2, the confirmation message is a positive acknowledgement message indicating that the data was decoded error-free, i.e. successfully at the at least one second receiving station, the at least one third receiving station may use this information to send its own confirmation message back to the transmitting station. Advantageously, according to this exemplary embodiment of the present invention, a needless feedback signaling of, for example, the positive or negative acknowledgement message from the at least one third receiving station in case the at least one second receiving station already sent a negative acknowledgement message, may be avoided. Due to this, the amount of signaling in the direction from the recipient to the sender, may be reduced, even if the number of recipients in the multicast group is large.

According to another exemplary embodiment of the present invention as set forth in claim 3, the transmitting station retransmits the data packet in case the confirmation message is a negative acknowledgement message. In other words, in case the at least one second receiving station was not able to decode the data packet error-free, the transmitting station initiates or starts a retransmission of the data packet without waiting for a feedback signaling of the other receiving stations in the multicast group.

Due to this, advantageously, since a retransmission for the data packet is anyway needed, this retransmission upon reception of a negative acknowledgement message allows to increase the efficiency of the data channel to the recipients, i.e. to reduce the transmission delay, since it is not necessary to wait with the retransmission until the last receiving station sent its feedback, and to increase the data transmission rate to receiving stations with only limited memory. Furthermore, due to the fact that the retransmission of the data is performed immediately after reception of a negative

acknowledgement message from one receiving station in the multicast group, the further confirmation messages from the other receiving stations do not need to be taken into account, i.e. may be ignored at the transmitting station, since the retransmission is performed anyway.

Due to this, advantageously, the transmission delay and data transmission rate to the recipients with limited memory may be increased and the amount of confirmation messages to be decoded by the transmitting station may be reduced.

According to another exemplary embodiment of the present invention as set forth in claim 4, the plurality of first receiving stations is grouped into a plurality of groups or subsets, wherein a feedback phase is assigned to each of the groups. Thus, the receiving stations of a group are scheduled to send their confirmation messages to the transmitting stations at a pre-set feedback phase.

In other words, according to this exemplary embodiment of the present invention, the set of recipients is split up into separate or disjoint subsets, whereby the members of each subset are assigned a pre-defined phase, for example, within the radio frame, which determines the structure of up-link and down-link transmissions in which phase the members of the subsets are allowed to transmit their confirmation messages. According to an aspect of this exemplary embodiment of the present invention, this feedback phase may also be a pre-defined slot or sub-frame in the up-link p2m control channel, which may accompany the data transmission via the p2m data channel.

Due to the prescribed feedback scheme, the transmission station "knows" at what phase, time, slot or channel the confirmation or feedback from the receiving stations of a group or subset is to be expected relative to the transmission of a data packet.

According to another exemplary embodiment of the present invention as set forth in claim 5, the feedback scheme is adapted such that the confirmation message of the first group or subset is decoded and mirrored back to the second group before the

transmission of the confirmation message of the second group starts. By this, advantageously, it may be ensured that the second group "knows" about the feedback of the first group and thus may decide to skip its own feedback, i.e. the sending of its own confirmation message.

Due to this, advantageously, the amount of signaling from the receiving stations to the transmitting stations may be reduced, which may allow to reduce interferences occurring in the channel to the transmitting station. Apart from this the receiving station may save battery energy.

According to another exemplary embodiment of the present invention as set forth in claim 6, the at least one fourth receiving station of the second group does not send its own negative acknowledgement message in the case of an unsuccessful decoding, if it received a negative acknowledgement message mirrored by the transmitting station indicating that the at least one third receiving station of the first group was not able to decode the data packet error-free.

According to another exemplary embodiment of the present invention as set forth in claim 7, the receiving stations of the multicast group only send the confirmation message in case the decoding of the data packet is unsuccessful, i.e. only send a negative acknowledgement message. Advantageously, this may allow to further reduce the amount of signaling between the recipients and the sender.

According to another exemplary embodiment of the present invention as set forth in claim 8, after a retransmission of the data, the transmission station listens only to confirmation messages of groups of the receiving stations which have not yet sent a positive acknowledgement message with respect to the data. In other words, after retransmission, the transmitting station only waits for a feedback of groups of receiving stations which have either already sent a negative acknowledgement message or did not send a positive acknowledgement message, due to the fact that other groups sent a negative acknowledgement message before them, so that they received a mirrored copy

of the negative confirmation message of another group before they were scheduled to send their own confirmation and decided not to send their own confirmation message.

According to another exemplary embodiment of the present invention as set forth in claim 9, the receiving stations are adapted such that only negative acknowledgement messages are sent to the transmitting station and the transmitting station initiates a retransmission of the data upon reception and decoding of the confirmation message. According to an aspect of this exemplary embodiment of the present invention, the transmitting station initiates a retransmission for a data packet upon reception and decoding of the first negative acknowledgement message from a receiving station or subset of receiving stations.

Advantageously, this may allow for a robust and efficient operation, while keeping the amount of signaling from the recipients to the sender low.

According to another exemplary embodiment of the present invention as set forth in claim 10, the transmitting stations are adapted to only send positive acknowledgement messages, indicating that the receiving station has decoded the data packet error-free. Then, the transmitting station initiates a retransmission for the data packet after not receiving a positive acknowledgement message from at least one receiving station.

Advantageously, this may allow to reduce the up-link interference (from the receiving stations to the transmitting stations), if only a few retransmissions are necessary. Thus, advantageously, this may allow to reduce the up-link interference in case of good reception conditions.

According to another exemplary embodiment of the present invention as set forth in claim 11, the data is sent as a data packet and the method is a retransmission protocol in a cellular radio communication system, such as, for example, a GSM mobile telecommunication system or the UMTS telecommunication system.

According to another exemplary embodiment of the present invention as set forth in claim 12, a data transmission system is provided for a point-to-multipoint data transmission from a transmission station to a plurality of first receiving stations, where the transmitting station is adapted to transmit a confirmation message with respect to the data from at least one second receiving station of the plurality of first receiving stations to at least one third receiving station of the plurality of first receiving stations.

Advantageously, due to the mirroring of the confirmation message from a receiving station to another receiving station, the other receiving stations are informed about a feedback of other receiving stations. This may allow to reduce a feedback signaling, i.e. a transmission of confirmation messages from the receiving stations to the transmitting stations.

According to another exemplary embodiment of the data transmission system of the present invention as set forth in claim 12, the receiving stations are grouped into groups or subsets, wherein the members of each group or subset are assigned a pre-defined feedback phase, which, according to an aspect of this exemplary embodiment of the present invention, determines the structure of up-link and down-link transmissions, in which phase the members of the group or subset are allowed or scheduled to transmit their respective confirmation messages. In this context, it should be understood that the feedback phase does not relate to a particular phase, but is to be understood as a particular point in time, time slot, transmission channel or sub-frame (relative to the transmission time, time slot or sub-frame, when a data packet is transmitted) in the up-link or down-link p2m control channel, which, according to an aspect of the present invention, accompanies the transmission of a data packet.

Claims 14 and 15 provide further exemplary embodiments of the data transmission system according to the present invention.

According to another exemplary embodiment of the present invention as set forth in claim 16, a transmission station for a data transmission system for a point-to-multipoint

data transmission from a transmission station to a plurality of receiving stations is provided. According to this exemplary embodiment of the present invention, the transmitting station is adapted to send a confirmation message received from one receiving station to another receiving station.

According to another exemplary embodiment of the present invention as set forth in claim 17, a receiving station is provided for a data transmission system for a point-to-multipoint data transmission from a transmitting station to a plurality of receiving stations. The receiving station is adapted to receive a confirmation message from another receiving station, which was sent from the transmitting station to the receiving station.

It may be seen as the gist of an exemplary embodiment of the present invention that the set of recipients of a multicast group is split up into separate or disjoint subsets, whereby the members of each subset are assigned, relative to the transmission of a data packet, a pre-defined phase within the radio frame, which determines the structure of up-link and down-link transmissions in which phase the members of the subset are allowed to transmit their feedback signals. According to an aspect of the present invention, use is made of the fact that in most cases there are already subsets for which the transmitting station has already received the subset feedback. This already received subset feedback is sent by the transmitting station to the "unfinished subsets with respect to the packet the feedback refers to", i.e. the subsets of receiving stations, which have not yet sent their feedback to the transmitting stations for this packet. In the following to denote this, also the expression "unfinished subset *of* a data packet" is used. Advantageously, this may reduce the amount of signaling in the direction from the recipients to the sender, i.e. from the receiving stations to the transmitting station.

These and other aspects of the present invention will become apparent from and elucidated with reference to the embodiments described hereinafter.

Exemplary embodiments of the present invention will be described in the following, with reference to the following drawings:

Fig. 1 shows a simplified representation of an exemplary embodiment of a data transmission system for a point-to-multipoint data transmission from a transmission station to a plurality of receiving stations according to the present invention.

Fig. 2 shows an exemplary embodiment of a method of operating the data transmission system depicted in Fig. 1 according to the present invention.

Fig. 3 shows another exemplary embodiment of a method of operating the data transmitting system depicted in Fig. 1 according to the present invention.

Fig. 1 shows a simplified representation of a data transmission system for a point-to-multipoint data transmission, from a transmitting station 2 to a plurality of receiving stations 4, 6, 12, 14 and 18. The data transmission system depicted in Fig. 1 is a wireless data transmission system, where data is transmitted from the transmitting station 2 via a wireless radio link in the form of data packets to the receiving stations 4, 6, 12, 14 and 18. The data transmission system depicted in Fig. 1 may, for example, be a cellular mobile radio telecommunication system, such as the GSM system or the UMTS system, or a wireless local area network.

The transmitting station 2 depicted in Fig. 1 is adapted to transmit data in the form of a data packet to the plurality of receiving stations 4, 6, 12, 14 and 18. Each of the plurality of receiving stations 4, 6, 12, 14 and 18 is adapted to send a confirmation message back to the transmitting station. These confirmation messages relate to a decoding of the data at the respective receiving station of the plurality of receiving stations 4, 6, 12, 14 and 18. The transmitting station 2 is furthermore adapted to transmit the at least one confirmation message received from one of the receiving stations 4, 6, 12, 14 and 18 back to the receiving stations 4, 6, 12, 14 and 18.

As may be taken from Fig. 1, the receiving stations 4, 6, 12, 14 and 18 are grouped into four subsets 8, 10, 16 and 20, such that the receiving stations designated by reference numeral 4 are located or belong to the subset 8, the receiving stations designated by reference numeral 6 are located or belong to the subset 10, the receiving stations 12 and 14 belong to subset 16 and the receiving station 18 belongs to subset 20.

In the data transmission system depicted in Fig. 1 there is a feedback scheme according to which a first feedback phase is assigned to subset 8 and a second feedback phase is assigned to subset 10. In other words, the receiving stations 4 in the subset 8 are all assigned a first feedback phase, during which or via which they are scheduled to transmit their confirmation message, i.e. feedback messages back to the transmitting station 2. This can mean that the feedback messages are sent one after the other during this feedback phase exclusively assigned to the subset, i.e. in a time division manner, or superimposed during the feedback phase, in which case the phase is usually shorter. Superposition can be advantageously been done by using Code Division Multiple Access (CDMA) techniques. It is, however, also possible to superimpose without applying CDMA, in which case the feedback signals collide. If only Negative Acknowledgements are sent, this collision does not pose a problem for the transmission side to detect that at least one receiving station requested a retransmission by means of a Negative Acknowledgement (NACK). Also, each of the receiving stations 6, 12, 16 and 18 of the subsets 10, 16 and 18 are assigned another feedback phase, during which, at which or via which they may send their confirmation messages back to the transmitting station 2.

In other words, as may be taken from Fig. 1, the set of receiving stations 4, 6, 12, 14 and 18 is split up into separated subsets 8, 10, 16 and 20, whereby the members of each subset 8, 10, 16 and 20 are assigned a predefined feedback phase within the radio frame of the wireless communication channels between the transmitting station 2 and the receiving stations 4, 6, 12, 14 and 18, which determines the structure of up-link and down-link transmission, in which phase the members of the subsets 8, 10, 16 and 20 are allowed to transmit their feedback signals. The feedback signal or confirmation message

is often also referred to as an ACK or NACK message. The ACK message is a positive acknowledgement message, which indicates that the data packet was decoded successfully without error at the respective receiving station 4, 6, 12, 16 and 18, whereas the NACK message is a negative acknowledgement message, which indicates that the receiving station sending this NACK message was not able to decode the respective data packet error-free, and therefore requests a retransmission. This phase of the feedback phase may also be looked upon as a pre-defined slot or sub-frame in the up-link or down-link p2m control channel, which accompanies the data packet transmission via the p2m data channel.

If the transmitting station hears at least one NACK in this phase or slot of the up-link control channel, it knows that a retransmission is required. Here, a subset-feedback is defined to be a NACK, whenever the transmitting station 2 receives at least one NACK from one receiving station of a respective subset. Accordingly, for example, the subset feedback of subset 16 is defined to be an ACK, if the transmitting station 2 receives an ACK from all receiving stations 12 and 14 in the subset 16.

In order to take advantage of the fact that in most cases there are subsets where the transmitting station 2 has already received the subset feedback for a particular packet (here called "finished subsets with respect to the packet", or "finished subsets *of* the packet", meaning that for the transmission of the considered data packet, they have finished conveying their feedback), and other subsets, whose receiving stations still have to send their feedback (here called "unfinished subsets with respect to the packet" or "unfinished subsets *of* the packet"), it may be advantageous to indicate the feedback of finished subsets to the unfinished subsets.

In other words, according to an aspect of this exemplary embodiment of the present invention, the feedback received from a receiving station is mirrored back to other receiving stations by the transmitting station, such that these other receiving stations are informed about the feedback. This information may be made such that the feedback of each of the receiving stations is mirrored to all of the other receiving stations. However,

this feedback mirroring may also be performed such that the feedback of a subset is mirrored to other subsets, which have not yet sent their feedback.

Advantageously, according to an aspect of the present invention, the feedback of the last subset, which just became a finished subset, is sent back to the other subsets.

This indication of the subset feedback (preferably of the last subset, which has just sent its feedback), may be performed in a phase in the down-link frame structure or a slot of the down-link p2m control channel, shortly after the up-link phase in which the last subset sent its feedback. Indicating the subset feedback for a subset in the down-link may only require one single bit (in order to distinguish between ACK and NACK).

Thus, according to the present invention, at a given point in time, each unfinished subset is informed about the subset feedback of the subset that last sent its feedback to the transmitting station. If the subset feedback indicated to the unfinished subsets (via the pre-defined phase in the down-link frame structure after the transmitting station 2 has decoded the subset feedback of the last subset, which sent its feedback or confirmation message) is a NACK, then all members of the unfinished subsets know that a retransmission will occur anyway, so that there is no need to send the feedback, regardless of whether the own feedback is an ACK or an NACK message. Advantageously, due to the fact that the unfinished subsets know about the fact that a retransmission for the data packet will occur anyway, they may refrain from sending their own feedback, such that the amount of signaling from these subsets to the transmitting station 2 may be significantly reduced.

Advantageously, due to this, the up-link interference may be reduced.

Advantageously, the transmission station 2 is adapted such that the transmitting station may initiate a retransmission of the data packets as soon as it receives an NACK, i.e. a negative acknowledgement message from one receiving station or from a subset comprising a plurality of receiving stations. If the transmission station does not initiate a

retransmission for a packet as soon as it receives a NACK from a subset of receiving stations, but continues transmitting new packets, it may be important that the receiving stations memorize the mirrored feedback for each received packet, in order to avoid needless feedback messages for packets, for which the mirrored feedback information already indicated that a retransmission will be initiated.

An alternative to this memorizing of feedback information of received packets, for which the transmitting station has not received the subset feedback of all subsets, is the following rule: For each packet, for which the transmitting station receives feedback information, the transmitting station indicates – in the next transmission on the down-link control channel, when the transmitting station is scheduled to indicate received feedback information for this packet to all receiving stations –

- a NACK, if the feedback information received so far for this packet was a NACK for *at least* one subset of receiving stations, and
- an ACK, if the feedback information received so far for this packet was an ACK for *all* of the receiving stations.

With this alternative, the receiving stations do not need to memorize the mirrored feedback information, *and* the transmitting station has the freedom not to initiate a retransmission for a packet as soon as it receives a NACK as subset feedback, but can initiate the retransmission also later on. If the retransmission is initiated as soon as the transmission station receives a NACK as subset feedback, this alternative becomes equivalent to the rule that the transmission station mirrors the subset feedback of the subset, that last sent its feedback.

With this alternative in mind, according to an aspect of the present invention, the current invention may also be looked upon as making the transmitting station indicate – based on subset feedback from the finished subsets of a packet – to the unfinished subsets of a packet, whether the transmitting station still intends to send a retransmission for this packet or not.

In the following, the four subsets 8, 10, 16 and 20 are considered in order to further explain the present invention. These four subsets 8, 10, 16 and 20 are configured to form a multicast group for receiving a point-to-multipoint (p2m) data transmission from the transmitting station 2 to the plurality of receiving stations 4, 6, 12 and 18. After a data packet transmission from the transmitting station 2, the transmitting station 2 waits for the subset feedback from the subsets 8, 10, 16 and 20. According to the present invention, the order of the feedback is prescribed by a feedback scheme. According to the feedback scheme of the data transmission system depicted in Fig. 1, the transmitting station 2 firstly waits for the subset feedback from subset 8, then from subset 10, then from subset 16 and then from subset 20.

In this context it should again be understood that a subset feedback relates to the confirmation messages sent from the receiving stations of each subset back to the transmitting station 2. In case one confirmation message sent by one receiving station of a plurality of receiving stations of a subset is a NACK, the subset feedback is considered to be a NACK. Only in the case that all confirmation messages from all receiving stations of a subset are positive acknowledgement messages ACK, is the subset feedback ACK.

For the feedback of each subset, the pre-defined phase in the up-link control channel between the transmitting station 2 and the respective receiving station of the receiving stations 4, 6, 12, 14 and 18 is left free, so that each member of the subset may convey its feedback. This phase may be made up of a number of time slots, or in a CDMA system, different channelization codes of the up-link control channel.

If the transmitting station 2 sends a package P1 and receives ACK as a subset feedback from subset 8, ACK as subset feedback for the subset 10 for P1 and then NACK as subset feedback from the subset 16, the transmitting station 2 may, directly after having decoded the NACK from the subset 16, initiate the retransmission for P1 without waiting for the subset feedback of the subset 20.

According to an aspect of the present invention, after this retransmission, the transmitting station 2 only waits for the subset feedback of those subsets which have not yet sent an ACK, i.e. in the present case for the subset feedback of the subset 16 and the subset 20. Subsets 8 and 10 do not send any feedback, i.e. confirmation messages, at this time, since they have already decoded P1 error-free, i.e. were able to decode P1 error-free as indicated by the earlier ACK transmissions from these subsets.

For this, it may be advantageous (in order to reduce the delay) to rearrange the up-link feedback phases for the subsets from which ACK have not yet been received, so that only these subsets send their feedback directly after retransmission. In other words, according to this aspect of the present invention, the feedback scheme may be adapted such that, for the retransmission, the feedback scheme assigns phases only to those subsets which have not yet sent an ACK.

This phase rearrangement in the feedback scheme may be indicated to the receiving stations via the down-link p2m control channel, which may control this retransmission protocol. The down-link p2m control channel may be forward error corrected (FEC), which, advantageously, allows that errors on this p2m control channel are extremely rare.

According to an aspect of the present invention, this down-link p2m control channel is advantageous also a p2m channel with no retransmission protocol on top, but a very strong FEC.

A link between the subset feedback and the transmitted data packet is, according to an aspect of the present invention, given by a pre-defined time difference between the point in time when the data packet being considered was sent, and the point in time when the respective subset sends its feedback. Also, the link between the subset feedback and the respectively transmitted packet may be given by a pre-defined time interval between the point in time when the packet was sent and the point in time when the base station indicated in the down-link frame (after the packet transmission) the subset feedback of

the last subset which provided its feedback. In other words, the link may also be based on the time difference between the transmission of the respective data packet and the mirroring of the feedback from the last subset to send its feedback.

In case the down-link p2m control channel is adapted to have a strong FEC as set forth above, i.e. in case it can be assumed to a high probability that no receiving station will miss or unsuccessfully decode the down-link p2m control channel, the ACK feedback may be omitted. In other words, the receiving stations 4, 12, 14 and 18 may be adapted such that they only send a NACK, but not an ACK feedback as confirmation message. Thus, a receiving station 4, 6, 12, 14 and 18 of a subset, which has correctly decoded the data packet, does not send a confirmation message. Only the negative confirmation message, the NACK feedback message, is transmitted if a transmitting station of the subset cannot decode a received data packet. This operation mode, where instead of one of NACK or ACK is omitted, i.e. no energy is sent at all, may also be referred to as discontinuous transmission (DTX).

This may be particularly advantageous in combination with the strong FEC of the down-link p2m control channel according to which all receiving stations may at least receive the down-link p2m control channel error-free. Missing the down-link p2m control channel (i.e. not decoding it error-free or not even receiving sufficient energy on it) would mean (together with the definition of DTX as ACK, i.e. no ACK messages), that the transmitting station 2 erroneously assumes that a data packet was received by the receiving station, which missed the down-link p2m control channel, although the data packet was not received, not even decoded. Assuming that the transmitting station sends a continuous stream of packets (including retransmissions), a way out of the problem of missing the down-link p2m control channel is making the receiving station send a NACK also, if it misses the downlink control channel during the continuous stream of packets.

With this assumption, it is still possible that the transmitting station serves different multi-cast groups (which are each decomposed in different sub-sets), in that data

transmission is done on a different channelization code or channelization code set for each of the multi-cast groups.

Advantageously, the omission of ACK messages, i.e. the definition of DTX as ACK may allow to reduce the up-link interference, i.e. the interference occurring in the transmission path from the receiving stations to the transmitting station, if only a few retransmissions are necessary, i.e. only a few NACKs are sent.

In contrast, according to another aspect of the present invention, if many retransmissions are necessary, it may be advantageous to define DTX as NACK, i.e. to adapt the receiving stations such that they only send an explicit ACK feedback and do not send any NACK confirmation messages. If decoding was not successful, according to this aspect of the present invention, the receiving stations will not send any feedback. In this case, missing the down-link p2m data channel does not cause any further problems, since the DTX (i.e. the missing NACK) is interpreted as an NACK by the transmitting station.

Hence, according to the present invention, the transmitting station may, depending on the current channel conditions, inform the transmitting stations via the down-link p2m control channel, whether DTX should mean ACK or NACK. According to an aspect of the present invention, ACK and NACK use different code words, so that the transmitting station receives an indication whether the receiving stations have understood that DTX means ACK (while there is a code word expressing NACK) or DTX means NACK (while there is a code word expressing ACK).

The most robust operation according to a preferred embodiment of the present invention is the case where DTX means no NACKs, which, however, causes considerable ACK feedback, if channel conditions are good, so that each transmission is acknowledged positively by each receiving station in each subset. In this mode, however, it is necessary that the base station may resolve those receiving stations in a subset which were not able to decode the packet error-free, i.e. in this case, each receiving station of

each subset may have an exclusive time slot or channelization code assigned in accordance with the feedback scheme, to convey its ACK (or DTX).

In case DTX means ACK (i.e. no ACKs are sent; only NACKs are sent), it may be sufficient to provide exactly one time slot and channelization code to all receiving stations of a subset, since, as soon as one of the receiving stations of a subset needs a retransmission, it will generate and send a NACK, which then causes the subset feedback to become NACK. Since the transmitted energy of one or more NACK is superimposed, i.e. does not cause any interference so as to make the NACK unreadable for the transmitting station, this "one time slot and one channelization code" design may be sufficient. In other words, a collision of a plurality of NACKs in this one time slot or one channelization code design does not cause any problems for the transmitting station in detecting the correct subset feedback.

For the above described data transmission via the p2m channel with a retransmission protocol, it may be advantageous according to an aspect of the present invention, to apply a soft combination of earlier transmissions of a data packet and a further retransmission of this data packet. For example, the so-called Chase Combining may be applied. According to the Chase Combining, the soft-bits of a transmission are added to the soft bits of a previous transmission of the same packet, and then the decision is taken about whether each resulting soft-bit represents a logical "One" or a logical "Zero". Alternatively, the retransmission of self-decodable or non-self-decodable redundancy bits may also be possible.

Fig. 2 shows a timing chart of an exemplary embodiment of a method of operating a data transmission system according to the present invention. The timing charts depicted in Fig. 2 refer to a data transmission system including three subsets SS1, SS2 and SS3, each comprising one or more receiving stations.

The same numbering is assumed for the slots of the p2m data channel and the p2m control channel in Fig.2.

The ACK messages are indicated with an "A" and the NACKs with an "N". The first number designates the serial number of the data packet, to which the feedback message refers, and the second number the serial number of the subset, to which the receiving stations belong, which send the feedback message.

Reference numeral 30 in Fig. 2 designates the p2m control channel from the transmitting station to the receiving stations. Reference numeral 32 designates the p2m data channel for transmitting the data packets from the transmitting station to the receiving stations, and reference numeral 34 designates the up-link (UL) control channel from the receiving stations to the transmitting station.

According to an aspect of the present invention, in order to avoid endless retransmissions for each data packet to be transmitted, a 1-bit sequence number (1-bit-SN) is introduced (indicated in the first line of chart 30) to indicate whether the data packet is a first transmission of new data or a retransmission. This 1-bit sequence number is sent as part of the p2m control channel. The initial transmission and subsequent retransmissions of the same packet use the same 1-bit sequence number, 1-bit-SN. A new transmission of the next data packet is indicated to the receiving stations by toggling the 1-bit sequence number compared with the previous transmission and by this toggling, an on-going transmission for a data packet can be stopped, in other words "be aborted".

In addition, the p2m control channel furthermore indicates to the recipients, the address of the soft buffer (the upper area of the p2m control channel includes the 1-bit SN and the soft buffer address) for which a transmission is planned, since several, i.e. N_{slot} packets may be under transmission after each other, until all subsets have provided feedback to the transmitting station. According to an exemplary embodiment of the present invention, the soft buffer places may be numbered, where each number represents a soft buffer address. Ceil(log2 ($N_{soft\ buffer}$)) bits are needed on the p2m control channel to code all $N_{soft\ buffer}$ soft buffer places, where "Ceil(x)" denotes the

smallest integer number, which is greater or equal to x, and log2 is the logarithm with respect to the base of 2.

Since the sequence of data packets may change during transmission, according to an exemplary embodiment of the present invention, a packet sequence number (PSN) is sent as part of each packet ("in-band via the p2m data channel") in addition to the 1-bit SN sent on the p2m control channel so that the receiving stations may reconstruct the order of the data packets after decoding the data packets error-free.

The boxes 36 to 88 in the p2m control channel shown in timing chart 30 and in the UL control channel shown in timing chart 34 represent one bit for each subset SS1 to SS3. That means that if this bit is set, this may e.g. indicate to the receiving stations that the corresponding data packet was positively acknowledged by the last receiving subset feedback. The link with the data packet is given by the fixed relation between the slot in the p2m control channel (timing chart 30), in which this bit is conveyed, and the slot in the p2m data channel in which the data packet was sent.

As may be taken from Fig. 2, the data packet P1 is sent in the (N + 1)-th slot of the p2m data channel (timing chart 32). Then, the decoding time necessary for the subset SS1 to decode P1 and send for each subset member the confirmation message contained in A1-1 (box 60), which depicts here the subset feedback, to the transmitting station is the length of one slot. Since the data packet P1 was decoded error-free by all receiving stations of the subset SS1, the subset feedback A1-1 is an ACK message. Then, as may be taken from Fig. 2, this positive decoding of data packet P1 by the subset SS1 is indicated to the other subsets in the (N + 4)-th slot of the p2m control channel shown in timing chart 30, as indicated in Fig. 2 by box 36. Furthermore, the subset feedback A2-1 indicating an ACK message depicted by box 62 in the timing chart 34 indicating the error-free decoding (by all members of SS1) of the data packet P2 sent in (N + 2)-th slot of the p2m data channel shown in timing chart 32 by the subset SS1, is indicated to the other subsets in the (N + 5)-th slot of the p2m control channel shown in timing chart 30, as indicated by box 38.

Furthermore, the indication of correct decoding of the data packet P1 by the second subset SS2, derived from the subset feedback A1-2 indicating an ACK (box 66), which is sent in the (N + 5)-th slot of the UL control channel shown in timing chart 34, is mirrored, i.e. indicated to the other subsets in the (N + 6)-th slot (box 40) of the p2m control channel 30. Furthermore, the subset feedback, i.e. the ACK A1-3 (box 76) of the third subset SS3 is sent to the transmitting station in the (N + 7)-th slot of the UL control channel shown in timing chart 34. Since there are only three subsets, there is no need to mirror the feedback of the third subset SS3, since this mirrored feedback is of no use for the other subsets.

The reason for the relatively long distance (in slots) between the transmission of the data packet P1 and the feedback indication in the p2m control channel is due to the time necessary for decoding the packet in each receiving station of each subset, as well as evaluating the received subset feedback in the transmitting station, as well as evaluating the feedback indication in each receiving station. Depending on the decoding speed in the receiving stations and the processing time required in the transmitting station to evaluate the subset feedback, this distance may also be smaller.

Since the feedback indication, i.e. the mirroring or signaling of the feedback or confirmation messages of receiving stations or subsets to other receiving stations or subsets is spread over as many slots of the p2m control channel as there are subsets in the multicast group, each slot of the p2m control channel has to accommodate several bits for the feedback indication, one for each subset.

As may be taken from Fig. 2, ("number of subsets" –1) bits are necessary; i.e., in Fig. 2, two bits are necessary for the mirroring of three subsets. Thus, the (N + 6)-th slot of the p2m control channel shown in timing chart 30 carries one bit, i.e. box 42, which is the feedback indication mirroring the subset feedback ACK A3-1 of the first subset SS1 of receiving stations which received the data packets P3 in the ([N + 6] – 3) -th = (N + 3)-th slot of the p2m data channel. Furthermore, the (N + 6)-th slot of the p2m data channel

carries a further bit, i.e. box 40, which is the feedback indication mirroring the subset feedback ACK A1-2 of the second subset of receiving stations, which received the data packet P1 in the ([N + 6] – 3 – 2) -th = (N + 1)-th slot of the p2m data channel.

Since, in the exemplary embodiment depicted in Fig. 2, there are only three subsets, there is no need to monitor the subset feedback of the third subset, i.e. to indicate the subset feedback of the third subset SS3 to the other subsets via the p2m control channel. This is due to the fact that the third subset SS3 is the last subset to send its feedback, i.e. no other subset of the multicast group needs to know about the feedback of this subset SS3.

Fig. 3 shows timing charts of an exemplary embodiment of a method of operating a data transmission system according to the present invention, where data packets P1, P2 and P4 need retransmissions.

The channel structure depicted in Fig. 3 corresponds to the channel structure depicted in Fig. 2. Reference numeral 100 designates a timing chart depicting successive slots of the p2m control channel from the transmitting station to the receiving stations. As in Fig. 2, the first slot on the left side of the p2m control channel is the (N + 2)-th slot. Towards the right side of Fig. 3, the slot number is incremented by 1. The upper area shaded in grey of the (sketchy representation of the) p2m control channel contains the 1-bit-SN and the soft buffer address and the lower area shaded in darker grey shows the indication portion or payload portion of each slot containing one bit (box 106 to 124) for each subset SS1 to SS3. However, it should be noted that, as in Fig. 2, a signaling for the respective last, i.e. third subset, i.e. the signaling of the confirmation message of the last, i.e. third unfinished subset is not necessary, i.e. ("number of subsets"-1) bits are sufficient.

Timing chart 102 shows the p2m data channel and the transmission of data packets P1 to P7 in the respective slots. Timing chart 104 shows the UL control channel from the receiving stations to the transmitting station. Since the channel structure depicted in Fig.

3 is the same as depicted in Fig. 2, reference is made to Fig. 2 for a further description of the channel structure. Also, as in Fig. 2, the multicast group for which the signaling is depicted in Fig. 3 contains three subsets SS1 to SS3.

The numbering of the slots is assumed to be the same for the p2m control channel, the p2m data channel and the UL control channel. As may be taken from timing chart 104, for each member of a subset two bits are necessary to report the decoding results from the receiving stations back to the transmitting stations. N1-1 (box 126), N2-1 (box 128) and N4-2 (box 140) represent the subset feedback, which is here NACK, from the receiving stations to the transmitting station. N1-1 represents the subset feedback (indicating NACK) of the first subset SS1 for the packet sent in the (N + 1)-th slot, i.e. P1. N2-1 (box 128) is the subset feedback (indicating NACK) of the first subset SS1 for the packet sent in the (N + 2)–th slot, i.e. P2. N4-2 (box 140) is the subset feedback (indicating NACK) of the second subset for the data packet P4 sent in the (N + 4)-th slot of the p2m data channel. As in Fig. 2, the subset feedback indicating ACK are depicted with an "A" in the box (boxes 130, 132, 134, 136, 138, 142, 144, 146) whereas the subset feedback indicating NACKs are depicted by "N" (boxes 126, 128, 140). The first number in the boxes designates the number of the data packet to which this subset feedback refers and the second number indicates the subset SS1 to SS3 to which the subset feedback refers.

As may be taken from Fig. 3, two bits, i.e. ("number of subset" – 1) bits are a sufficient payload size for the p2m control channel for a multicast group containing three subsets. As will be explained in the following, this number of feedback indication bits in the p2m control channel is even sufficient in the case that a retransmission of data packets is necessary.

As depicted in Fig. 3, the packet P1 sent in the (N + 1)-th slot of the p2m data channel is unsuccessfully decoded by the first subset SS1, such that the NACK messages are sent from the members of the first subset to the transmitting station via the UL control channel. This is depicted by the subset feedback N1-1 (box 126) of the first subset to the

transmitting station via the UL control channel. Then, after a certain time delay required for evaluating the subset feedback N1-1 (being a NACK) at the transmitting station, the transmitting station mirrors this NACK as N1-1 (box 106) to the other subsets and therewith to the other receiving stations in the (N + 4) -th slot of the p2m control channel. Due to the subset feedback (box 126) indicating NACK in the (N + 3)-rd slot of the UL control channel, the transmitting station retransmits the data packet P1 in the (N + 5)-th slot of the p2m control channel, as indicated by P1'. In Fig. 3, retransmissions for a data packets are indicated by a " ' ". They can be exact copies of the initially transmitted packet (then they are called retransmissions *of* the packet), or can contain e.g. only additional parity bits (which covers the case of non-self-decodable incremental redundancy) or e.g. all systematic bits together with other parity bits compared with the initial transmission (which is a general example for the case of self-decodable redundancy).

Furthermore, the first bit, i.e. box 112 in the (N + 7)-th slot of the p2m control channel, mirrors the subset feedback of the first subset SS1 for the packet P4 transmitted in the ([N + 7] – 3)-th = (N + 4)-th slot of the p2m data channel. The second bit in the (N + 7)-th slot of the p2m control channel would refer to the subset feedback of the second subset of receiving stations, which received the data packet transmission P2 in the ([N + 7] – 3 – 2)-th = (N + 2)-th slot. Since, however, P2 is already retransmitted (P2') in the (N + 6)-th slot, due to the fact that the first subset SS1 already indicated as subset feedback a NACK N2-1 (box 128) in the (N + 4)-th slot of the UL control channel to the transmitting station, this second bit in the (N+7)-th slot of the p2m control channel has no meaning (therefore is not shown in the figure) and is thus ignored by the receiving stations, which are aware of the P2' retransmission.

It has to be noted that Figs. 2 and 3 do not show that the p2m control channels may also carry information with respect to a redundancy version of a retransmission, if, for example, the Chase Combining (i.e. the retransmission for a data packet is an exact copy of the initial transmission) is not used, i.e. if self-decodable and non-self-decodable redundancy transmission schemes are applied.

In addition, in order to make the p2m control channels more strongly FEC protected, according to the present invention, they may also carry CRC (Cyclic Redundancy Check) bits, which are also not shown in Figs. 2 and 3. Furthermore, the modulation and coding scheme may also be indicated via the p2m control channel to the receiving stations, if different modulation and/or coding schemes are to be applied, as well as an indication of the number of user-bits (i.e. uncoded), which are carried within one packet (so-called "transport block size"), so that the receiving side may derive from the number of coded bits it receives, which puncturing scheme was applied.

According to an aspect of this exemplary embodiment of the present invention, the mirrored subset feedback on the p2m control channel may be sent as the first part of the corresponding slot of the p2m control channel and may be protected with a separate CRC, different from the CRC of the other information carried on the p2m control channel, in order to allow for a very fast decoding of the subset feedback by the receiving stations without the other information carried on the p2m control channel. If CDMA technology is applied, this part of the p2m control information could also be sent on a different channelization code or code set.

According to an aspect of this exemplary embodiment of the present invention, if CDMA technology is applied and the number of channelization codes may be changed from one transmission to the next, an indication of the used channelization codes may also be carried out via the p2m control channel. If the p2m control channel is used for controlling transmissions to several multicast groups, wherein each multicast group is organized in different subsets, the p2m control channel may also contain an identification of the respective multicast group. Furthermore, according to a further exemplary embodiment of the present invention, it may be advantageous, especially for decoding purposes, to shift the p2m control channel in time with respect to the p2m data channel, so that information carried in a slot of the p2m control channel is available earlier than the data sent on the p2m data channel associated with the information in the

slot of the p2m control channel. In such a case, the slots of the p2m control channel are shifted in time to the left side with respect to Figs. 2 and 3.

The fact that it may take a number of slots until all groups have provided their feedback may require for a continuous stream of data packets via the air interface (in the case of a wireless data transmission) that the receiving stations or recipients are able to store a number of data packets, which might be out of sequence. In a best case, needing, however, a maximum memory, after transmission of a packet A, which is received by all transmitting stations error-free, as many further packets may be sent as slots (N_{slot}) are required, until all subsets have provided their ACK feedback for the packet A. If one of the subsets sends a NACK, this will cause a retransmission directly afterwards, i.e. whilst the slot is then used for retransmission, so that fewer packets than N_{slot} have to be stored.

According to an aspect of the present invention, an improved delay reduction may be achieved, if the assignment of receiving stations to the subsets is performed in such a way that receiving stations which have a high likelihood of needing several retransmissions are within the same subset and/or within the first ones of the subsets scheduled to send their feedback to the transmitting station in accordance with the feedback scheme. Then, NACKs would be received at the earliest point in time, which allows that retransmissions may be initiated at the earliest possible point in time.

An assignment to the subsets could be done explicitly by means of a configuration message sent to each receiving station. For a huge number of receiving stations, this might not be feasible, and in such a case, according to an aspect of this exemplary embodiment of the present invention, the assignment may be done implicitly: For example, in the case of mobile phones, each mobile phone has a unique subscriber identity (IMSI: International Mobile Subscriber Identity). From its IMSI, each mobile phone may compute the subset to which it belongs, if it only knows the number of subsets which are to be configured. This number of subsets to be configured $N_{subsets}$, according to an aspect of the present invention, is indicated to the mobile phone (i.e. the

receiving stations) e.g. via the p2m control channel, or even by a broadcast message sent over another downlink channel, and the respective subset for each mobile phone may then be computed by means of the following formula:

$$\text{"Assigned subset"} = \text{IMSI mod } N_{subsets}.$$

Especially in large multicast groups, it has been found, according to the present invention, that it may be beneficial to accept that some of the transmitting stations finally may lose a data packet. This would result, if the subset feedback were defined to be only a NACK, if not only one but a number of recipients, pre-defined by a threshold, send a NACK in the phase reserved for feedback transmission for this subset. This means that only if the number of NACKs conveyed is larger than the threshold, the transmitting station or base station assumes that the subset feedback is a NACK and therefore initiates a retransmission. This, however, only works if DTX = ACK (only NACKs are sent).

According to a further aspect of this exemplary embodiment of the present invention, a further reduction of the up-link interference may be achieved, if only those recipients in a subset send their feedback, which have moderate or bad channel conditions, but not receiving stations which have good channel conditions. This may then be evaluated locally in each station, and each station itself would take the decision to send feedback or not. The alternative of conveying measurement results for the perceived channel conditions may be efficient in some cases.

According to a further aspect of the present invention, in a TDD (Time Division Duplexing) system, it may not be necessary to provide the feedback via the p2m control channel, since receiving stations may hear the up-link transmission of other stations, since up-link and down-link share the same frequency band, and hence may get to know the subset feedback by this means. However, even in such a case, it may be advantageous to let the transmission station or base station mirror the feedback, since it

is not guaranteed that all receiving stations of the multicast group can hear all of the other members of the multicast group.

CLAIMS

1. Method of performing a point-to-multipoint data transmission from a transmitting station to a plurality of first receiving stations, the method comprising the steps of:

transmitting data from the transmitting station to the plurality of first receiving stations;

receiving a confirmation message with respect to the data from at least one second receiving station of the plurality of first receiving stations at the transmitting station;

transmitting the confirmation message from the transmitting station to at least one third receiving station of the plurality of first receiving stations.

2. The method of claim 1,

wherein the confirmation message is at least one of a negative acknowledgement message indicating that the at least one second receiving station unsuccessfully decoded the data and a positive acknowledgement message indicating that the data was errorlessly decoded at the at least one second receiving station.

3. The method of claim 2,

wherein, when the confirmation message is a negative acknowledgement message, the transmitting station retransmits the data.

4. The method of claim 2,

wherein the plurality of first receiving stations is grouped into a plurality of groups of first receiving stations such that a first group includes at least one third receiving station of the plurality of first receiving stations and a second group includes at least one fourth receiving station of the plurality of first receiving stations;

wherein a first feedback phase is assigned to the first group and a second feedback phase is assigned to the second group in accordance with a feedback scheme;

wherein the at least one third receiving station sends the confirmation message to the transmitting station in accordance with the first feedback phase and the at least one fourth receiving station sends the confirmation message in accordance with the second feedback phase.

5. The method of claim 4,

wherein, after the transmitting station has received and decoded the confirmation message from the at least one third receiving station of the first group, the transmitting station sends the confirmation message, which it received from the at least one third receiving station of the first group, to the at least one fourth receiving station of the second group;

wherein the feedback scheme is adapted such that the confirmation message of the at least one third station of the first group is decoded at the transmitting station and sent to the at least one fourth receiving station of the second group before the at least one fourth receiving station sends the confirmation message to the transmitting station.

6. The method of claim 5,

wherein, when the confirmation message decoded at the at least one fourth receiving station is the negative acknowledgement message, the at least one fourth receiving station of the second group does not send its own negative acknowledgement message..

7. The method of claim 4,

wherein the at least one third receiving station and the at least one fourth receiving station only send the confirmation message in case the decoding of the data of the at least one third receiving station and the at least one fourth receiving station is unsuccessful such that the at least one third receiving station and the at least one fourth receiving station only send the negative acknowledgement message indicating that the data could not be decoded error-free.

8. The method of claim 4,

wherein, after a retransmission of the data, the transmitting station listens only to third groups of the plurality of groups which have not sent the positive acknowledgement message with respect to the data;

wherein the third groups are considered to have sent the positive acknowledgement message in case all of the receiving stations belonging to the groups have sent the positive acknowledgement message.

9. The method of claim 1,

wherein the confirmation message is a negative acknowledgement message indicating that the at least one second receiving station could not decode the data error-free; and

wherein the transmitting station retransmits the data upon reception and decoding of the confirmation message.

10. The method of claim 1,

wherein the confirmation message is a positive acknowledgement message indicating that the at least one second receiving station decoded the data error-free; and

wherein the transmitting station retransmits the data after not receiving the confirmation message from one of the plurality of first receiving stations.

11. The method of claim 1,

wherein the data is a data packet;

wherein the method is a retransmission protocol in a cellular radio communication system.

12. Data transmission system for a point-to-multipoint data transmission from a transmitting station to a plurality of first receiving stations,

wherein the transmitting station is adapted to transmit data from the transmitting station to the plurality of first receiving stations;

wherein each of the plurality of first receiving stations is adapted to send a confirmation message to the transmitting station;

wherein the confirmation message relates to a decoding of the data at the respective receiving station of the plurality of first receiving stations;

wherein the transmitting station is adapted to receive a confirmation message with respect to the data from at least one second receiving station of the plurality of first receiving stations; and

wherein the transmitting station is adapted to transmit the confirmation message, which it received from at least one second receiving station, to at least one third receiving station of the plurality of first receiving stations.

13. The data transmission system of claim 12,

wherein the plurality of first receiving stations is grouped into a plurality of groups of first receiving stations such that a first group includes at least one third receiving station of the plurality of first receiving stations and a second group includes at least one fourth receiving station of the plurality of first receiving stations;

wherein a first feedback phase is assigned to the first group and a second feedback phase is assigned to the second group in accordance with a feedback scheme;

wherein the at least one third receiving station sends the confirmation message to the transmitting station in accordance with the first feedback phase and the at least one fourth receiving station sends the confirmation message in accordance with the second feedback phase;

wherein, after the transmitting station has received and decoded the confirmation message from the at least one third receiving station of the first group, the transmitting station sends the confirmation message, which it received from the at least one third receiving station of the first group, to the at least one fourth receiving station of the second group;

wherein the feedback scheme is adapted such that the confirmation message of the at least one third station of the first group is decoded at the transmitting station and sent to the at least one fourth receiving station of the second group before the at least one fourth receiving station sends the confirmation message to the transmitting station.

14. The data transmission system of claim 13,

wherein, when the confirmation message from the at least one third receiving station of the first group is the negative acknowledgement message indicating that one or more of the at least one third receiving station unsuccessfully decoded the data, the at least one fourth receiving station of the second group is adapted to not send the confirmation message.

15. The data transmission system of claim 13,

wherein the at least one third receiving station and the at least one fourth receiving station only send the confirmation message in case the decoding of the data at the at least one third receiving station and at the at least one fourth receiving station is unsuccessful such that the at least one third receiving station and the at least one fourth receiving station only send the negative acknowledgement message indicating that the data could not be decoded error-free.

16. Transmitting station for a data transmission system for a point-to-multipoint data transmission from the transmitting station to a plurality of receiving stations,

wherein the transmitting station is adapted to transmit data from the transmitting station to the plurality of receiving stations;

wherein the transmitting station is adapted to receive a confirmation message with respect to the data from at least one first receiving station of the plurality of receiving stations;

wherein the confirmation message relates to a decoding of the data at the at least one first receiving station of the plurality of receiving stations; and

wherein the transmitting station is adapted to transmit the confirmation message, which it received from the at least one first receiving station, to at least one third receiving station of the plurality of receiving stations.

17. Receiving station for a data transmission system for a point-to-multipoint data transmission from a transmitting station to a plurality of receiving stations,

wherein the receiving station is adapted to receive data sent from the transmitting station to the plurality of receiving stations;

wherein the receiving station is adapted to send a first confirmation message to the transmitting station;

wherein the first confirmation message relates to a decoding of the data at the receiving station;

wherein the receiving station is adapted to receive a second confirmation message which is sent from the transmitting station;

wherein the second confirmation message relates to a decoding of the data at another receiving station of the plurality of receiving stations.

ABSTRACT

Data transmission in a multicast fashion usually causes difficulties when retransmissions are applied in order to increase the chance of correct decoding for a maximum of recipients, since each recipient has to send the feedback separately to the one sender, which may cause a huge amount of feedback signaling in case the multicast reception group is large. According to the present invention, receiving stations are informed about the feedback of another receiving station. This is done by mirroring the feedback of receiving stations to other receiving stations. Due to this, in case, for example, one of the mirrored feedbacks is a negative acknowledgement message, the other receiving stations are informed that it is no longer necessary to provide their feedback, since a retransmission will be initiated anyway. Advantageously, this may allow to reduce interference in the direction of the feedback.

(Fig. 3)

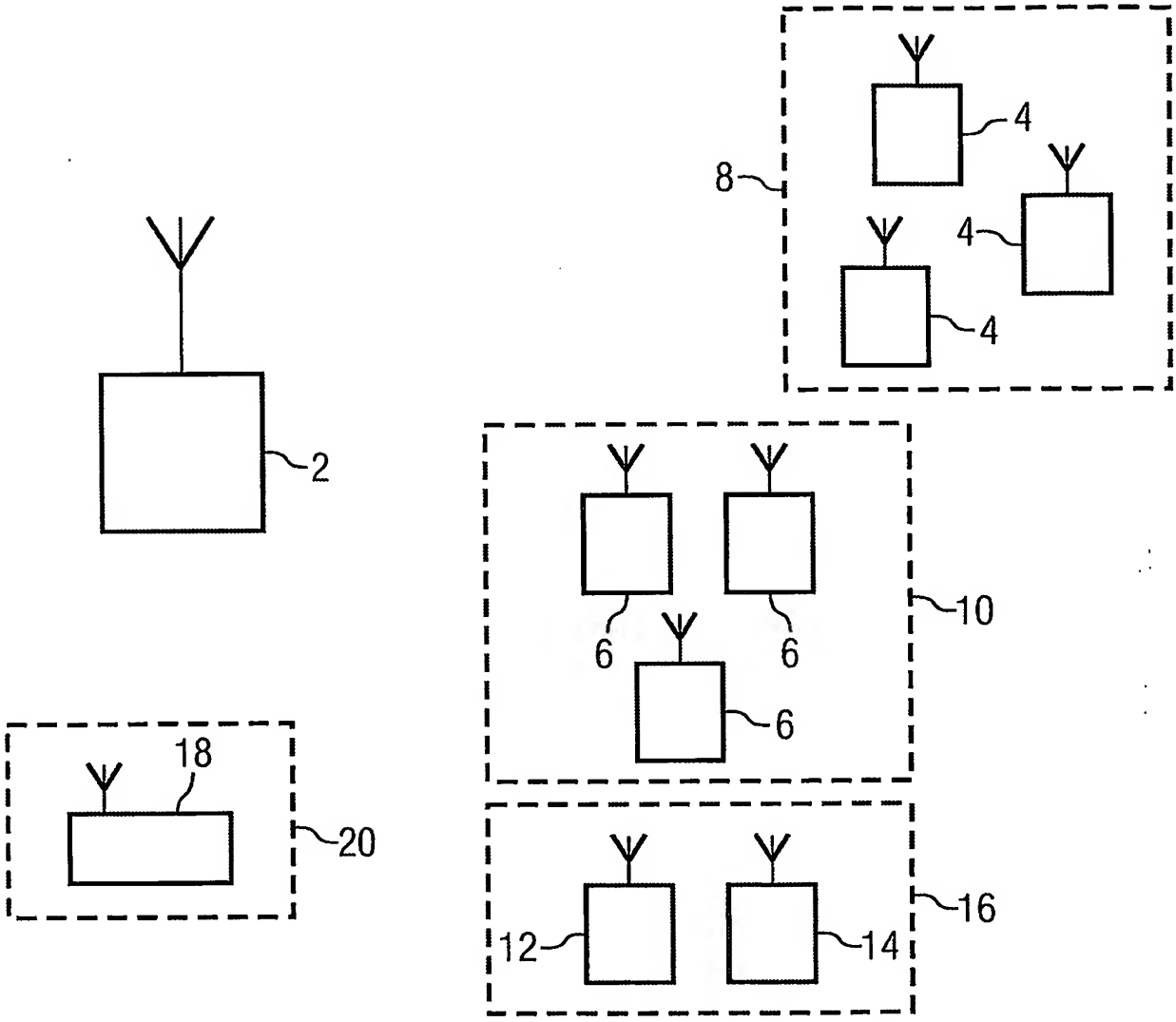
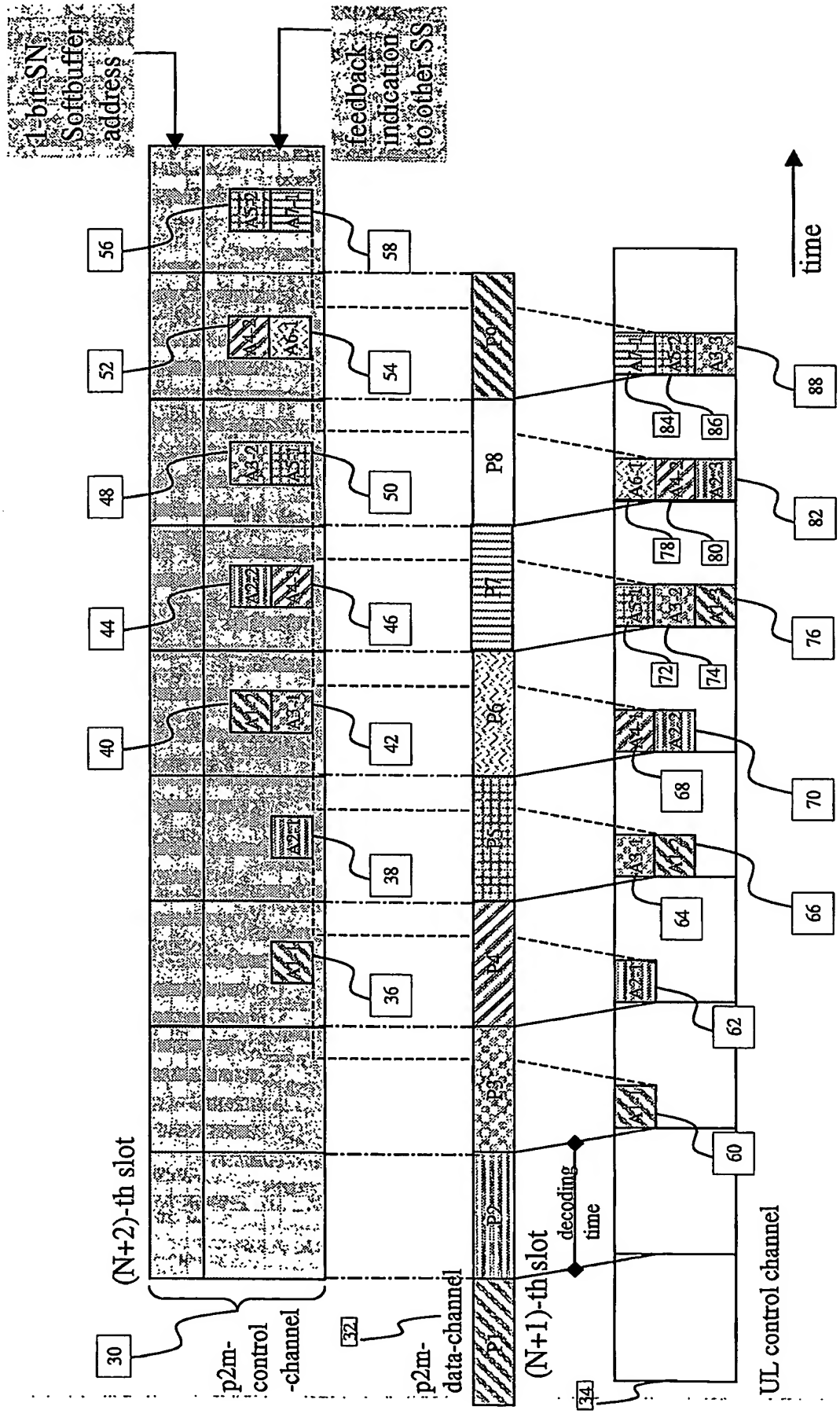


FIG 1


11-bit-SN
Softbuffer
address
feedback-
indication
to other SS
time
(N+2)-th slot
(N+1)-th slot
p2m-
control
-channel
p2m-
data-channel
decoding
time
UL control channel
P0
P1
P2
P3
P4
P5
P6
P7
P8
30
32
34
36
38
40
42
44
46
48
50
52
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86
88

Fig. 2

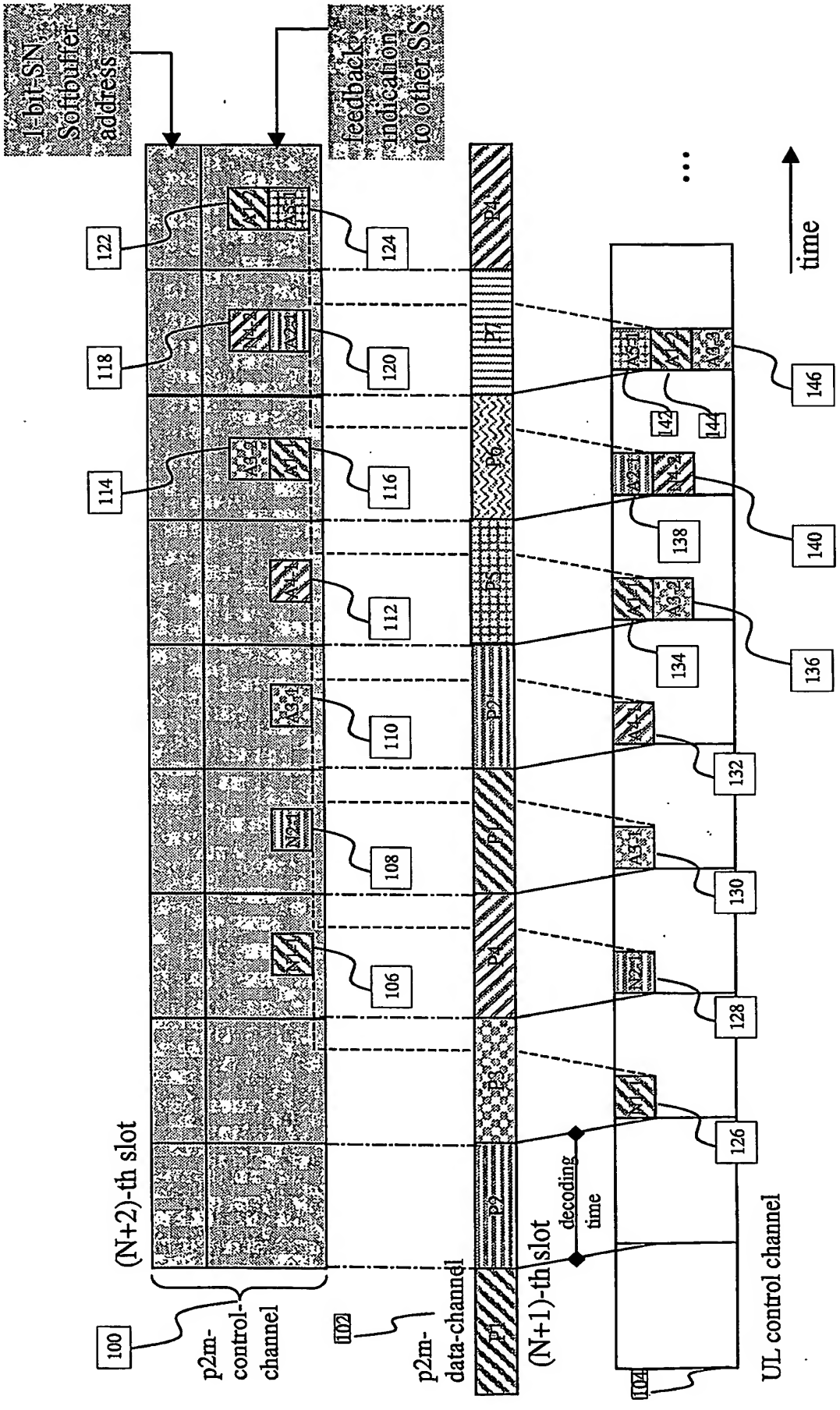
1-bit SN
Softbuffer
address
feedback
indication
to other SS
(N+2)-th slot
(N+1)-th slot
p2m-
control-
channel
p2m-
data-channel
decoding
time
UL control channel
time
100
102
104
106
108
110
112
114
116
118
120
122
124
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Fig. 3

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